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CONTROL OF APHIDS ON ALFALFA IN THE
ANTELOPE VALLEY, CALIF.

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INTRODUCTION

The attacks of the pea aphid (*Illinoia pisi* Kalt.) on alfalfa have caused considerable loss of this crop in the Antelope Valley and in other districts in southern California since 1924. At times the cowpea aphid (*Aphis medicaginis* Koch) also becomes numerous in alfalfa in this district but not sufficiently so to cause economic losses. Recent investigations have shown that a number of control methods are valuable in reducing the damage caused by the pea aphid to alfalfa under conditions like those prevailing in the Antelope Valley. These control methods are discussed briefly in this circular.

SEASONAL HISTORY OF THE PEA APHID

The pea aphid on alfalfa gives birth to living young during the fall, winter, and spring months. An occasional egg of this species is found on alfalfa during the winter, which indicates that the aphid also perpetuates itself to some extent through eggs. Females containing living young, as well as young aphids, can be found feeding on the young green shoots below or near the bases of the crowns of alfalfa in most fields throughout the winter. At this season the aphids multiply very slowly; in most fields they produce only enough young to maintain the species at a low ebb. As the weather becomes warmer and the alfalfa begins to make more rapid growth, the aphids multiply more rapidly and soon build up large populations. Early in the season almost all the aphids are wingless females, but as the season progresses and the populations become large enough to cause

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a lessening in the succulence of the alfalfa, winged females develop in large numbers and migration takes place. These winged migrants are carried long distances by the wind, as they have been observed in the air and alighting on the desert at least 11 miles distant from any alfalfa.

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When the weather becomes warm enough for good alfalfa growth, the aphid populations decline very rapidly. Starvation and desiccation of the aphids caused by the drying up of the alfalfa, migration of winged females, attacks of predatory insects, toughening of the plant tissues, and destruction by fungous diseases, all contribute to the disappearance of the aphids. There is also evidence tending to show that the aphids go through a definite cycle on alfalfa, and that after completing this cycle they must go to other plants for a time. During the summer it is often impossible to find a single aphid on alfalfa in the Antelope Valley. Two probable ways in which aphids may survive the summer are (1) by migrating to sweetclover and other legumes in the foothills surrounding the valley, from which they return in the early fall, and (2) by being able to live through the summer on alfalfa in the more protected places in the valley. In the late spring of 1933 an occasional wingless female capable of laying eggs was found on the alfalfa, and it may be that the most unfavorable part of the summer season is also passed in the egg stage.

TYPES OF SEASONS OBSERVED

During the 5 years for which weather records have been kept in the Antelope Valley, three types of spring seasons have been observed. These will be discussed briefly, as the success of control measures depends to a great extent upon the type of season in a given year. Two years, 1929 and 1933, had retarded spring seasons with no long periods of good growing weather until late in April or early in May. Freezing temperatures occurred as late as the second week in April. In 1932 the season was slightly less retarded, good growing weather beginning early in April. Two years, 1930 and 1931, had advanced spring seasons, good growing weather beginning by the middle of March.

Retarded spring seasons, like those of 1929 and 1933, result in very heavy aphid infestations and consequent widespread damage to the alfalfa. Studies have shown that although the aphids increase more slowly in retarded than in advanced seasons, they accumulate more rapidly than the alfalfa grows. There are also periods of a few days or a week of warm weather during which the alfalfa starts to grow rapidly and the aphids multiply rapidly also. Cool weather and frosts following these warm spells check the alfalfa growth and lessen the rate of increase of the aphids as well, but the populations which have accumulated during the warm spells gradually become large enough to destroy much of the alfalfa growth.

In seasons like that of 1932, having a cold winter and an early spring, with a gradual warming up beginning early in April, the aphid infestations are light in most fields, because the aphids are not able to accumulate rapidly during the winter and early spring, and the alfalfa can make a gradual growth and reach the point where it is not susceptible to aphid damage, before large populations accumulate. Aphids multiply more rapidly where sudden spurts of growth occur than where the plants develop gradually.

During advanced seasons the alfalfa grows rapidly, provided moisture is supplied by rainfall or by irrigation; the aphids likewise multiply rapidly. Occasional heavy frosts early in the spring retard the growth in many fields, thereby increasing aphid damage. The damage is less serious and less widespread and the infestation is of shorter duration during advanced seasons than during retarded ones.

RELATION OF SOIL TYPE TO INFESTATION

It has been observed that the aphids multiply more rapidly in fields having light sandy soils. This no doubt is due to the fact that these soils warm up more rapidly, thus causing an increased growth of the alfalfa for the aphids to feed on during the winter and early spring. Alfalfa in these sandy soils is likely to be damaged every year, whereas in the loam and sandy loam soils it occasionally escapes damage. Alfalfa in the adobe soils is damaged only occasionally, such damage occurring during years having retarded spring seasons. As a general rule, during intermediate seasons, such as that of 1932, alfalfa is damaged only in fields having light sandy soils, whereas during advanced seasons it is damaged on sandy and sandy loam soils, and during retarded spring seasons the stand in fields of all kinds of soil types is likely to be damaged. During seasons of heavy infestation the aphids in the sandy-soil fields may cause severe damage and largely disappear and the alfalfa may begin to recover, before the infestation becomes serious in fields having heavy soils.

METHODS OF CONTROL

PASTURAGE AND CULTIVATION

The practice of pasturing heavily has prevented aphid damage in all years except those having retarded spring seasons. The alfalfa must be kept eaten down very short until warm weather and vigorous growth begin. Pasturing favors weeds, unless the animals are forced to eat the weeds through hunger. Pasturing, therefore, may not be advisable where high-quality market hay is desired. Pasturing during the winter, followed by cultivation in the early spring before the alfalfa has made abundant growth, has resulted in good aphid control even in years having retarded spring weather. Cultivation during the winter and early spring with a disk or spring-tooth harrow has given good aphid control during normal years. Cultivation is a dangerous practice, however, because bacterial wilt, which is a serious disease in the Antelope Valley, may be spread in this manner.

EARLY IRRIGATION

Early irrigation as a means of avoiding aphid damage depends upon the type of weather following irrigation and the size of the aphid population early in the season. When the alfalfa has begun to make good growth in the spring, it should be examined to determine the number of aphids present. If the aphid population is already large, irrigation should be delayed; but if there are very few aphids, the soil should be kept moist, provided warm weather assures good growth. Keeping the soil moist in such fields has resulted in a larger crop in 3 out of 5 years. During years having retarded spring weather, however, early irrigation is not justified in most cases. In cases where (be-

cause of early aphid infestation or cool spring weather) the alfalfa had been damaged by aphids, the second crop grew more rapidly and the plants had a healthier appearance in the fields that received very little moisture, especially those on light sandy soils.

EARLY CUTTING

Fields of alfalfa are often destroyed by aphids after the alfalfa has reached a height of 10 inches or more, which would yield a short crop of high-grade hay. In many such cases cutting the hay has resulted in controlling the aphids as well as saving the crop. If the soil can be allowed to dry out somewhat before the alfalfa is cut, control of the aphids is accomplished more quickly. Such cutting should be done just before the damage begins to be severe over any considerable areas in the field. Many of the aphids will then be in the winged stage and will migrate from the field in large numbers, and a large proportion of the aphids will be weakened by lack of suitable food. If cutting is delayed too long, however, the quality of the crop is not only lowered, or destroyed, but also the plants tend to send up new shoots to which the aphids often transfer and thereby prolong the infestation. The early cutting should be done during warm weather, if possible, but it has proved a practical control method even when followed by a long period of cool weather. Where early cutting has been done at the proper time, the second crop has matured much more rapidly than where the first crop was allowed to be destroyed by the aphids. Where the crop is so short that a good job of cutting cannot be done, it should be left uncut and irrigation should be withheld until the aphids have completed their feeding. Continued cutting of the crop at an early stage of growth tends to shorten the life of the alfalfa plants, but severe aphid injury is also a factor in shortening the life of the stand.

RESISTANT PLANTS

Certain plants in the more severely damaged fields often grow normally and remain green and relatively uninfested throughout the season. Many such plants make good growth during the cool spring weather and are not damaged by comparatively severe frosts. The resistance to aphid damage seems to be coupled with the ability of the plants to make steady growth and develop toughened stems at temperatures below those necessary for the growth of other plants in the field. Attempts are being made to secure pure-line seed from some of the best of these plants to test the possibility of obtaining strains of alfalfa resistant to aphid attack.

APPLICATION OF GRANULAR CALCIUM CYANIDE

The application of 22 to 25 pounds of granular calcium cyanide per acre affords good control of aphids on new-growth alfalfa. This material costs 18 to 20 cents per pound in 100-pound drums. The material should be applied when the ground and plants are dry, to avoid serious burning. The material may best be applied with an alfalfa or grain drill, with the hose connections detached so that the cyanide will fall on the ground. The best results are obtained when a canvas 20 to 25 feet long is dragged behind the seeder. Great care should be exercised in handling or applying the calcium cyanide, as it is extremely poisonous if breathed or otherwise taken into the body.

It should not be applied during windy weather. The hydrocyanic acid gas escapes into the air a short time after the cyanide is applied to the alfalfa, leaving no residue poisonous to stock.

BURNING

Burning over alfalfa by means of mechanical burners in the spring is an effective control of aphids on alfalfa, provided such burning be done at the proper time. In the Antelope Valley spring burning cannot be effectively done before March 12, because of the danger of reinfestation, and the latest time for profitable burning is about March 28. A summary of the results obtained and the cost of treatment with two types of field burners is given here. For more complete information concerning the construction and operation of these field machines, consult United States Department of Agriculture Circular 287, Burning for the Control of Aphids on Alfalfa in the Antelope Valley, California.

The best of several types of experimental machines tested was an air-atomizing type. It was drawn by a tractor, with a power take-off to drive the pump and blower supplying the oil and air to the burners. The fuel was supplied through air-atomizing burner nozzles of a commercial type under a pressure of 40 pounds to the square inch. The frame of the hood was of structural steel. The hood was built of sheets of chromium-iron alloy to prevent oxidation at high temperatures. These sheets, overlapping one another, were supported from overhead supports at intervals of 6 inches in two directions. The cost of burning with this machine, including oil, labor, cost of equipment,² repairs, interest, and depreciation, was \$5.08 per acre for a single burning, and \$9.66 for a double burning. A double burning was not necessary with this machine.

Another machine that has been used considerably in the Antelope Valley is the Canadian stubble burner, which is equipped with generative-type burners. Considerable trouble has been experienced with the clogging of the burners due to formation of carbon. The hood covering the burners is not durable enough to withstand the high temperatures developed by the flames and has a comparatively short life in field service. It is necessary to burn over a field twice with this machine to do a good job. The most satisfactory fuel is distillate having specific gravities ranging from 38° to 42° Baumé. The cost of burning with this type of burner was estimated at \$2.51 per acre for one burning, and \$5.02 for double burning.

Burning over the alfalfa in these tests has resulted in an increase in the quantity of hay harvested from the first crop as well as in hay of better quality. Frequently the hay from untreated fields is not marketable, or can only be utilized as fertilizer hay, whereas alfalfa from properly burned fields has been of a higher grade and has sold for a better price than alfalfa from unburned fields. Burning results in a considerable reduction in the weed growth. The best weed control was observed in cases where burning was done when weeds were heading out. Considerable foul growth has been observed in fields in the year following burning, showing that weed seeds in the soil are not destroyed. No damage to the vitality of alfalfa traceable to burning has been observed. Burning cannot be

² The cost of equipment, exclusive of tractor, was \$1,400. A commercial type of burner could be constructed for approximately \$1,000.

recommended as a universal practice, as the age and health of the alfalfa, the degree of aphid infestation, and the probable price of hay in any season must be taken into consideration before decision is made as to whether burning will be profitable.

MEASURES NOT FOUND SUCCESSFUL

Dragging the alfalfa with brush, platform, or chain drags resulted in from 50 to 80 percent of control, depending upon the number of times the area was treated. The aphids are checked considerably but not sufficiently to save the crop. Spraying and dusting with materials and by methods of application known at present have thus far proved of no value. Applications of fertilizer sulphur, up to 400 pounds per acre, have had no noticeable effect upon the aphids.

SUMMARY

The pea aphid causes severe losses to alfalfa in the Antelope Valley and other sections of southern California. Here the aphids exist as females containing living young, or as young aphids, during the fall, winter, and spring. An occasional aphid egg has also been found in winter. During the summer the aphids survive on sweetclover and other legumes in the foothills surrounding the Antelope Valley, although an occasional aphid may live through the hot weather on alfalfa in protected places in the valley. Egg-laying females were found in the late spring of 1933.

In the last 5 years (1929-33) 3 types of spring seasons were recorded—2 having early spring weather, 2 having retarded spring weather, and 1 intermediate in type. Control measures are greatly influenced by the weather. Alfalfa grown on sandy soils is more susceptible to damage than that grown on sandy loam and loam soils, whereas alfalfa grown on heavy soils is damaged only during retarded springs.

Aphid damage is prevented by pasturing, provided it is thorough and is continued until rapid growth begins. Pasturing followed by cultivation results in good aphid control.

Thorough winter and early spring cultivation is effective. Bacterial wilt may be spread in this manner, however.

Early spring irrigation is a good practice in seasons when the aphids have not accumulated by the time the alfalfa has made good growth and during seasons having warm or moderate spring weather. Warm or moderate seasons are those having good growing weather by March 15 and no damaging frosts after April 1. During other seasons it is better to leave the fields dry until after the aphid infestation is over.

Early cutting of the crop is a successful method of control, where the plants reach a height of 10 to 12 inches before damage is severe.

From 22 to 25 pounds of granular calcium cyanide, scattered under canvas by a seeder, will control aphids on new-growth alfalfa. This material costs 18 to 20 cents per pound. Extreme care should be exercised in handling the cyanide, as it is extremely poisonous.

Burning with a mechanical burner is the only method known that will destroy a severe infestation on a mature stand of alfalfa that is too short to be cut. The total cost of such treatment will average approximately \$5 per acre.

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